# 'Hold Your Breath' Activity

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You will need:

- **Nothing but living, breathing people!**

Background:

In the previous demo ('Tale of Two Acids'), you made an important point about what ocean acidification is *not:* it is *not* the dramatic decrease in pH that the term might suggest. Nevertheless, ocean acidification poses a serious threat to marine organisms, because even a small decrease in pH can make their lives much more stressful. The 'Hold Your Breath' activity makes this point in a very personal way, by allowing people to experience ocean acidification in their own bodies. As they hold their breath, $CO_2$ builds up in their systems, causing the pH of their own blood to drop slightly. You can assure your audience that they will not be harmed by this exercise, and that they can resume breathing whenever they like. The point is for them to feel mild discomfort while you talk through the following paragraph.

Narrative:

"Globally, the pH of ocean surface waters has declined by 0.1 pH units since humans began burning fossil fuels. This may not seem like much, but consider that most of the biochemical reactions that support life have evolved to function in a fairly narrow chemical 'comfort zone'. Even the seemingly small 0.1 unit decline in ocean pH is already pushing some marine organisms, like oysters and pteropods, outside of their comfort zone."

"I want you to do an experiment with me that will help put this into context for you. Starting now, I'd like all of you to hold your breath. Raise your hand when you start to feel uncomfortable. Most of your probably think that the urge to breath you'll soon be experiencing is your brain telling you that you're running low on oxygen. Actually, your brain has no idea what the level of oxygen in your blood is—that's not the way it monitors whether you're breathing or not. What your brain is actually sensing is an *increase* in the level of $CO_2$ in your blood, building up because you're not exhaling ($CO_2$ is the waste product of your own body's metabolism). The same thing is happening in your bloodstream right now that has been happening in the oceans since humans began releasing large amounts of $CO_2$ into the atmosphere. $CO_2$ is reacting with water in your blood and forming carbonic acid, which is making your blood just slightly more acidic (refer back to the pH scale; normal blood pH is between 7.35 and 7.45). Unless you hoed your breath until you were about to pass out, your blood pH probably wouldn't drop by the amount that the ocean has already declined as a result of ocean acidification (0.1 pH units). The medical term

for elevated $CO_2$ levels in your blood is 'hypercapnia'. If your blood pH *were* to drop by 0.1 pH units, it would be quite obvious that something was wrong with you; you would have trouble thinking clearly, your speech might be slurred, and your balance would be off. People might think you were drunk. If your blood pH were to drop by 0.3 units, you'd go into a coma, and perhaps even die. The bad news is: at our current rate of $CO_2$ emissions, a 0.3 to 0.4 pH unit decrease is exactly where the oceans are headed by the end of this century. What does this mean for marine life, and the terrestrial organisms (including us) who depend on the ocean for food, habitat and oxygen*?"

As a preamble to the subsequent demonstration "Shells on Acid", you will want to explain that even though marine animals need oxygen just like us, and some, like the Humboldt Squid, do seem to experience respiratory distress in high $CO_2$ environments (http://blogs.discovermagazine.com/notrocketscience/2008/12/16/climate-change-squeezes-jumbo-squid-out-of-oxygen/#.VW3p-1xVikp), the most direct and widespread impact of acidification on marine life so far has been on a large group of organisms called 'calcifiers'—animals and plants that use calcium carbonate to build their shells and exoskeletons.

*see "Every other breath you take comes from the ocean": http://blog.ldeo.columbia.edu/2013report/investigating-tiny-marine-plants-for-clues-to-future-climate/ Note: the microscopic marine algae in this article, *Emiliana huxleyi* (http://en.wikipedia.org/wiki/Emiliania_huxleyi) has a calcium carbonate exoskeleton, and may be negatively affected by ocean acidification.